DOCUMENT RESUME

ED 146 417 CE 013 453

AUTHOR Taylor, Virginia
TITLE Individualized Calculus for the "Life-Long" Learner: A Two-Semester Comparison of Attitudes and Effectiveness.
PUB DATE 77
NOTE 14p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Academic Achievement; *Adult Students; *Calculus; Dropout Rate; Educational Research; Evening Students; Group Instruction; *Individualized Instruction; Individualized Programs; *Lecture; Methods Research; *Student Attitudes; Undergraduate Students

ABSTRACT

A study was performed to examine the attitudes of adult students toward a new mode of instruction (individualized instruction including modularized self-paced units) and to determine course effectiveness in terms of completion rates and final examination results. The subjects were sixty-five adult students who were enrolled in two calculus classes (Calculus I and II) over a two-semester period. The responses to attitudinal questionnaires were used to determine the attitudinal changes of the two classes of adult learners over two semesters. An analysis of common final examination scores was completed and a comparison was made to another calculus class taught in the conventional lecture method. The findings indicate (1) a much higher completion rate for students in individualized instruction, (2) a much lower formal course withdrawal rate for the individualized group of students, and (3) more highly positive attitudes toward individualized instruction. (Attitudinal questionnaires for Calculus I and II and three tables comparing the final grades, completion rates, and final examination statistics for the individualized and conventional lecture classes are appended.) (EM)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

INDIVIDUALIZED CALCULUS FOR THE "Life-Long" LEARNER: A TWO-SEMESTER COMPARISON OF ATTITUDES AND EFFECTIVENESS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Dr. Virginia Taylor
Mathematics Department
University of Lowell
Lowell, Massachusetts 01854

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Virginia Taylor
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND THE ERIC SYSTEM CONTRACTORS."

ED146417

Engineering and science education for the adult-learner is difficult at best. In addition to the usual stresses of combining employment, formal education and family responsibilities, the engineering adult-learner is in a demanding field. Not only do these fields require a background of mathematics but they are changing at an ever accelerating pace.

In the main, the adult-student has many deficiencies in mathematics. Some of the deficiencies are due to a lack of background, and some are due to not using the mathematics taken many years ago.

Mathematics is a key subject in engineering education. It is fundamental to both the basic sciences and to all engineering curricula. Consequently, mathematics often critically filters students. Therefore, mastery-level achievement in mathematics is of fundamental importance. Without a sufficient knowledge of mathematics, the student's career choice is limited.

Walter R. Lynn, Director of the School of Civil and Environmental Engineering, Cornell University, in discussing engineering curriculum states that 70 to 85 percent of the conventional engineering curricula are comprised of either science or engineering, with the remaining percentage in Liberal studies. Hence, deficient background in mathematics can and often does have a profound negative effect on the engineering student.

Two classes of adult students enrolled in various engineering or pure science programs of the Division of Evening Studies (DES) at University of Lowell, were the subjects of this study. (Lowell Technological Institute and Lowell State College merged in July 1975 to form University of Lowell.)

CE 013 453

The University, a state institution, is located in a city of about 90,000 and comprises two major campuses on either side of the Merrimack River, in northeastern Massachusetts.

The purpose of this study was to examine the attitudes of the students to the new mode of instruction and to ascertain the effectiveness of the course in terms of completion rate and final examination results. First, attitudinal changes of the adult-learners enrolled in an engineering or pure science curriculum over two semesters was determined (Appendices A and B). Secondly, an analysis of common final examination scores was completed (Appendices C and D). The comparison was made to another Calculus I course taught in the conventional lecture method. Some variables, such as instructor, could not be controlled. But, the students were not self-selected, nor did any of the over 40 students enrolled in the Individualized class choose to transfer to a conventional lecture class when it was decided to split the class into two classes. (Another instructor was hired to specifically teach in the same style.)

The two classes, Calculus I and II, a total of 65 students, were taught in a PSI style during Fall 1976 and Spring 1977. The modularized self-paced units were developed by this writer for the individualized classes. This Individualized Calculus program was developed, in part, with the support of XPRT, a National Science Foundation funded consortium of Drexel University.

All DES courses are offered one evening per week (7-10 PM) for 15 weeks. The flexibility of the Individualized Calculus program at Lowell involves: (1) the scheduling of proctors two evenings per week, from 6-9 PM, (2) offering a brief summary lecture each week, (3) offering a brief lec-

ture of the "Unit of the Week", and (4) the instructor working with each student on a one-to-one basis each week. During both (2) and (3) students are free to go to adjacent study areas or to the proctor room for individual work or unit testing.

The analysis of the attitudinal questionnaire (Appendix A) administered for the first time in November 1976 indicates that all, 100%, either "agree strongly" or "agree" with question 9; i.e., the recycling feature of Keller courses is an advantage. The second highest score of 92% was on question 7, involving the "concrete terms, (which) the students knows exactly what to study."

Questions 11, 12, and 13 all directly involving lecture classes, indicate highly positive results for the nonconventional class. All results, given as a percentage, are incorporated in Appendix A.

The same questionnaire was administered to Calculus II in February 1977. The results are extremely similar, but the student attitudes in favor of the PSI class are even stronger (Appendix B). For example in questions 10, 11 and 13 changes of 15% or more occurred in response to questions about proctor interaction, lecture courses and grading. In addition, the entire class again favored the recycling feature of the course the second time they were questionned.

Comparison of the common Final Examination scores between the individualized and lecture classes indicate a difference of 14% in the mean, in favor of the individualized class (Appendix D). The variation was approximately the same for both. But, more significant are the results given in Table 1. Note that nearly twice the number of students received a grade of C or better in the alternative form of instruction.

Table 1
Grades Received in Calculus I (DES)
(Fall 1976)

Grade	Individualized Class N=24	Lecture Class N=20
A-AB	46%	10%
A-BC	54%	14%
A-C	67%	35%

Certainly the recycling feature and the mastery feature is reflected by these results. That is, the opportunity to learn with feedback on assessment quizzes appears to have made a difference in the final results.

Another positive feature of the individualized class is in the completion rate. 67% of students enrolled in this class completed the course, whereas only 35% of students enrolled in the conventional lecture class completed the course. An even more outstanding feature of the individualized class is that only 8% of the total number of students enrolled withdrew; in comparison, 35% of the lecture class withdrew (Appendix C).

Further thought as to why increased effectiveness appears to be evident should involve a more critical examination of the attitudes developed in individualized instruction classes. Individualized instruction appears to cause a change in the student's attitude toward learning. Fletcher and Tyler (1972); Green (1971); Hapkiewicz (1971); McMichael and Corey (1969); Riner (1972) and Roth (1973) are representative of reports which indicate that when compared to the lecture class, the individualized class produces significantly more positive attitudes. This increase in favorable attitude to-

ward self-paced learning is then combined with the increased amount of actual learning which takes place. Specifically, it appears that individualized courses increase the student's ability to be independent, adaptive and a decision-maker in his own education. According to Maslow (1954) these characteristics, which are an integral result of every PSI course, would define the highest level of self-actualization of an individual. It may be that Maslow's conclusions are too broad to be supported by the available evidence. The correct hypothesis may be that because individualized or PSI instruction causes each student to take on the responsibility for his own learning we are likely to see that this type of acceptance of responsibility tends to improve the effectiveness of learning in all areas.

For the adult-learner this shift of responsibility will be a positive orientation toward continuing self-development throughout life. This certainly is the primary focus of all continuing education programs. Styles of presentation which help to utilize the students time in the best way possible, need to be thoroughly investigated.

Some changes in the conventional lecture method could be immediately adopted. Suggestions include: (1) Frequent mini-exams, which are self-graded, or graded immediately and returned to the students, (2) Students given a syllabus of the course, (3) Students given a brief listing of objectives for each week's assignment, (4) A set of previous course examinations, including final examination, given to students or located at the Reserve Desk in the library. (5) The long three-hour class period split into a variety of activities. (Although, some of the students are spending 4 hours, rather than 3, for the Calculus course in an evening, they like the flexibility and the various activities; of course, they enjoy their success. They have remarked, they like mathematics ...

they know where and how to get help when necessary.)

More research should be undertaken on the longitudinal effect of individualized instruction, particularly on the adult-learner. Recommendations for further study are made in the interest of generalizing the conclusions and obtaining further information concerning individualized instruction and continuing eduction.

(1) The initial recommendation is that a competency examination be given to all first semester calculus students in order to establish a baseline of their incoming knowledge.

(2) Studies should be conducted to examine grades achieved in the subsequent lecture course of the particular field which is being individualized. i.e., in mathematics the studies should involve grade achievement in the Advanced Calculus course which is taught by lectures.

(3) Studies should be conducted with a variation of instructors.

(4) Similar studies over other disciplines should be investigated.

In conclusion, the primary focus of this study was to examine the effect of two forms of instruction on continuing education. Neither the individualized classes or the lecture class were self-selected and the same basic text was used for all classes. The findings indicate: (1) successful completion rate by a factor of 2 for individualized instruction, (2) less than one-fourth the withdrawal rate for the individualized group, and (3) highly positive attitudes for individualized instruction.

The individualized calculus course appears to exercise a very positive influence on the continuing education student. The adult students need for competency-based, effective

education is, needless to say, of primary importance. The changing needs of society have caused large groups of individuals to seek retraining. The needs of these adult-learners are different from those of the typical 18-year old entering college. Recurrent education must be accessible, effective and hopefully provide for a degree of self-sufficiency in order that the process of education truly becomes that of a continuing education.

APPENDIX A

CALCULUS I - DIVISION OF EVENING STUDIES

ATTITUDINAL QUESTIONNARE (Developed by C.T.I., Drexel University.)

	A	N	D*
1. Keller courses generally put less pressure on the student.	70	0	30
2. An advantage of Keller courses is that there is no need to attend class on schedule.	60	4	36
3. Keller courses are easier because there are no home-work problems to hand in.	15	15	70
4. One thing certain is that Keller courses take more of the student's time.	65	15	20
5. It is also pretty clear that the student must learn more details to pass the course in Keller sections.	65	21	14
6. But mastery feature of a Keller course is good because the student is better prepared for the next course.	78	18	4
7. Besides, since unit or module objectives in Keller courses are stated in concrete terms, the student knows exactly what to study.	92	4	4
8. Keller courses require taking a test with each unit or approximately once a week. This is worse than taking the 2 or 3 tests a term in a "regular" course.	26	0	74
9. In a Keller course, it is an advantage to be able to fail a unit test and be "recycled" without prejudice to your grade.	100	0	0
10. Another advantage is that the student has one-on-one interaction with a proctor or coach.	74	14	12
11. Lecture courses have a big advantage since you actually can learn more from someone who really knows his subject.	35	30	35
12. Besides, lectures are much more interesting than talking to some student coach or student proctor.	14	17	69
13. In a lecture or discussion course, even if you know the material really well, you can still get a low grade. This won't happen in the Keller course.	35	30	35
14. In fact, you stand a greater chance of getting an "A" in the Keller course if you want one because Keller grading is not "on the curve."	74	22	4
15. All things considered, I plan to sign up in the Keller section of the next course I take that offers one.	84	12	4

Note: All numbers are percentages.

* A = Agree Strongly & Agree; N = No Opinion; D = Disagree & Disagree Strongly.

APPENDIX B

CALCULUS II - DIVISION OF EVENING STUDIES

ATTITUDINAL QUESTIONNAIRE (Developed by C.T.I., Drexel University.)

	A	N	D*
1. Keller courses generally put less pressure on the student.	64	5	32
2. An advantage of Keller courses is that there is no need to attend class on schedule.	41	9	50
3. Keller courses are easier because there are no homework problems to hand in.	18	9	73
4. One thing certain is that Keller courses take more of the student's time.	45	18	36
5. It is also pretty clear that the student must learn more details to pass the course in Keller sections.	55	9	36
6. But mastery feature of a Keller course is good because the student is better prepared for the next course.	82	18	0
7. Besides, since unit or module objectives in Keller courses are stated in concrete terms, the student knows exactly what to study.	91	5	5
8. Keller courses require taking a test with each unit or approximately once a week. This is worse than taking the 2 or 3 tests a term in a "regular" course.	9	9	82
9. In a Keller course, it is an advantage to be able to fail a unit test and be "recycled" without prejudice to your grade.	100	0	0
10. Another advantage is that the student has one-on-one interaction with a proctor or coach.	95	5	0
11. Lecture courses have a big advantage since you actually can learn more from someone who really knows his subject.	27	23	50
12. Besides, lectures are much more interesting than talking to some student coach or student proctor.	5	23	73
13. In a lecture or discussion course, even if you know the material really well, you can still get a low grade. This won't happen in the Keller course.	50	32	18
14. In fact, you stand a greater chance of getting an "A" in the Keller course if you want one because Keller grading is not "on the curve."	64	32	5
15. All things considered, I plan to sign up in the Keller section of the next course I take that offers one.	95	0	5

Note: All numbers are percentages.

* A = Agree Strongly & Agree; N = No Opinion; D = Disagree & Disagree Strongly.

APPENDIX C

FINAL GRADE DISTRIBUTION FOR CALCULUS I

Fall 1976

	Individualized Class	Conventional Lecture Class
Grade	Number	Number
A	9	1
AB	2	1
B	0	1
BC	2	0
C	3	4
D	0	0
F	6	6
W*	2	7
Total	24	20

Note. Same syllabus, text and final examination; different instructors.
*W = Withdrawn.

COMPARISONS OF COMPLETION

Calculus I - Fall 1976

(DES)

	Individualized	Conventional Lecture
Percentage Completed	67 %	35 %
Failed	24 %	30 %
Withdrawn	8 %	35 %
Number Who Took Final Examination	16 (67%)	8 (40%)
Number Who Took Final and Passed Course	16 (67%)	7 (35%)

APPENDIX D

FINAL EXAMINATION STATISTICS FOR INDIVIDUALIZED & CONVENTIONAL CLASSES

	Individualized Class	Conventional Class
Final Examination Mean	71.6	58.3
Final Examination S.D.	21.9	22.7

BIBLIOGRAPHY

Fletcher, O.J. & Tyler, D. E. Teaching veterinary pathology by autotutorial and learning mastery methods. Journal of the American Veterinary Medical Association, 1972, 161, 65070.

Green, B. A., Jr. Physics teaching by the Keller plan at MIT. American Journal of Physics, 1971, 39, 764-775.

Hapkiewicz, W. G. Mastery learning options in teaching educational psychology. Mimeographed manuscript, Michigan State University, 1971.

Lynn, W. R. Engineering and Society Programs in Engineering Education. Science, 1977, 195, 150-156.

Maslow, A. H. Motivation and personality. New York: Harper & Row, 1954.

McMichael, J. S. & Corey, J. R. Contingency management in in an introductory psychology course produces better learning. Journal of Applied Behavior Analysis, 1969, 2, 79-83.

Riner, J. Individualizing mathematics instruction. The American Mathematical Monthly, 1972, 79, 77-86.

Roth, C. H. Continuing effectiveness of personalized self-paced instruction in digital systems engineering. Engineering Education, 1973, 63, 447-450.

ABSTRACT

INDIVIDUALIZED CALCULUS FOR THE "LIFE-LONG" LEARNER: A TWO-SEMESTER COMPARISON OF ATTITUDES AND EFFECTIVENESS

Dr. Virginia Taylor, Ass't. Prof.
University of Lowell
Lowell, Massachusetts 01854

The vast diversity of both curricula and student backgrounds has necessitated an individualized calculus program. The adult-learners often need a more flexible mode of learning due to: (1) employment schedules, and (2) uneven backgrounds.

The unique feature of our PSI program is its flexibility. This flexibility accommodates differences in work schedules, backgrounds, and even the snow storms of 1977.

The attitudes of the PSI classes in Calculus I and II were measured on an XPRT* prepared questionnaire of 15 statements over a six-month interval. The initial highly positive results increased significantly during Calculus II. Furthermore, analysis of common Final Examination scores at the end of Calculus I (December 1976) indicate that mastery-level learning is highly effective.

*XPRT is a National Science Foundation program of Drexel University; the Individualized Calculus program is supported, in part, by XPRT.